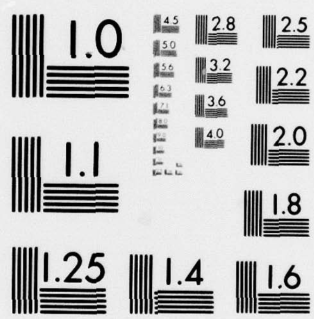
AD-A080 110 ARMY SAFETY CENTER FORT RUCKER AL F/G 1/2
SURVEY OF FORCED AND PRECAUTIONARY LANDING COSTS.(U)
JUL 79 E SPEZIA, G D KIMEL, T NEESE
UNCLASSIFIED USASC-TR-79-4 NL

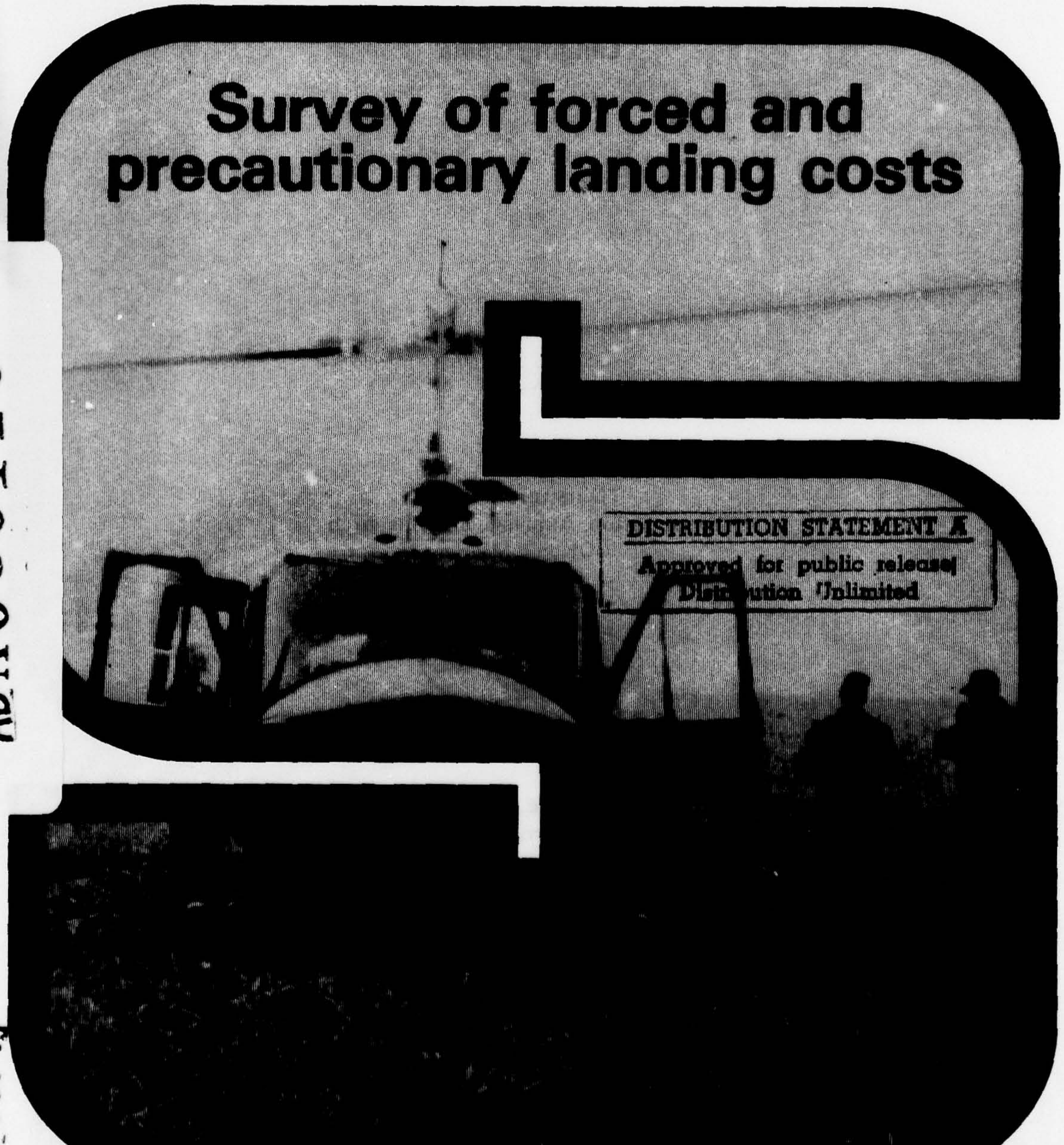
| OF |
AD
A080110

END
DATE
FILMED
3 - 80
DDC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Survey of forced and precautionary landing costs



USASC TECHNICAL REPORT ■ TR 79-4 ■ JULY 1979

U.S. ARMY SAFETY CENTER

Survey of Forced and Precautionary Landing Costs

by
Emil Spezia
SSG G. D. Kimel
T. Neese

Directorate for
Investigation, Analysis, and Research
COL J. J. Mikuta
Director

U.S. ARMY SAFETY CENTER

COLONEL E. E. WALDRON II
Commander

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER 9
4. TITLE (and Subtitle) 6 Survey of Forced and Precautionary Landing Costs.		5. TYPE OF REPORT & PERIOD COVERED Technical Report,
		6. PERFORMING ORG. REPORT NUMBER N/A
7. AUTHOR(s) 10 Emil Spezia, ~~SSG~~ G. D. Kimel, ~~and~~ Thomas Neese		8. CONTRACT OR GRANT NUMBER(s) N/A
9. PERFORMING ORGANIZATION NAME AND ADDRESS PESC-I US Army Safety Center Ft Rucker, Alabama 36362		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS N/A
11. CONTROLLING OFFICE NAME AND ADDRESS 12 24		12. REPORT DATE 11 July 1979
		13. NUMBER OF PAGES 17
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) 14 USASC-TR-79-4		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE N/A

16. DISTRIBUTION STATEMENT (of this Report)

Distribution of this document is unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

N/A

18. SUPPLEMENTARY NOTES

N/A

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Forced landings
Precautionary landings
Cost determination

Accession For	
NTIS GRA&I	✓
DDC TAB	
Unannounced	
Justification	
By	
Distribution/	
Availability Codes	
Dist. A	Avail and/or special

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A questionnaire survey was conducted to learn the costs of forced landings (F/Ls) and precautionary landings (P/Ls). The questionnaire elicited cost data in respect to (1) the effect each mishap had on the mission assigned the mishap aircraft, (2) man-hours lost by the crew and passengers, (3) man-hours required to recover the crew, passengers, and aircraft, (4) time the mishap aircraft was unavailable for flight, (5) man-hours required to make the aircraft flyable, and (6) the components that malfunctioned to cause these mishaps. The broad and obscure costs revealed by the survey are sufficient to justify the (cont'd)

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

411 551

LB

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

Block 20 cont'd

initiation of a concerted effort to prevent the causes of these mishaps. Prevention of the causes of these mishaps will allow aviation units to operate more efficiently, i.e., allow them to maintain a higher state of combat readiness.

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

Summary

A questionnaire survey was conducted to learn the costs of forced landings and precautionary landings. The questionnaire elicited cost data in respect to (1) the effect each mishap had on the mission assigned the aircraft, (2) man-hours lost by the crew and passengers, (3) man-hours required to recover the crew, passengers, and aircraft, (4) time the mishap aircraft was unavailable for flight, (5) man-hours required to make the aircraft flyable, and (6) the components that malfunctioned to cause these mishaps. Briefly, the survey revealed the following:

☐ The forced landing rate since 1 January 1971 remained essentially unchanged while the precautionary landing rate increased steadily at a rate of 3.64/100,000 flying hours per quarter.

☐ Forty-two percent of the forced landings and 39 percent of the precautionary landings caused the missions assigned the mishap aircraft to be cancelled.

☐ Twenty-four percent of the missions were carried out by a "second" aircraft.

☐ Two percent of the missions were carried out by another mode of travel.

☐ Man-hours lost by personnel aboard the mishap aircraft tended to vary with the effect the mishap had on the mission. The aviators' median lost time for a mission delayed less than an hour was 52 minutes. For missions delayed more than an hour, the lost time increased to more than 4 hours.

☐ Maintenance personnel, when required for recovery of the aircraft, were used an average of approximately 8 hours per operation.

☐ Mishap aircraft were out of service for an average of 44 hours.

☐ Recovery of "downed" aircraft was accomplished at the expense of scheduled ongoing operations, i.e., 80 percent of the cases required the services of unit maintenance personnel.

☐ Recovery of the aircraft was not required for 51 percent of the cases.

☐ When recovery was necessary, an average of 14 hours elapsed before recovery was complete.

☐ Sixty percent of the 159 malfunctioning components that were identified had a history of failure greater than 5 years, while 30 percent had a history of failure of at least 8 years.

☐ Sixteen components that were involved in 168 of 206 forced landings were also involved in 27 accidents and 1,085 precautionary landings.

☐ Twenty-five percent of these components cost not more than $45, 56 percent cost not more than $165, and 75 percent cost not more than $555.

CONCLUSIONS:

☐ The broad and obscure costs revealed by the survey are sufficient to justify the initiation of a concerted effort to prevent the causes of these mishaps.

☐ Prevention of the causes of these mishaps will allow aviation units to operate more efficiently, i.e., allow them to maintain a higher state of combat readiness during peacetime and a much higher availability rate during wartime.

RECOMMENDATIONS:

☐ That an assertive effort be made to turn back the long history of failure of a few relatively low-cost components that were involved in a disproportionately high number of forced landings, precautionary landings, incidents, and accidents.

☐ That a similar history of failure of a few components not be allowed to occur in the next generation of aircraft, i.e., UTTAS, AAH, ASH.

Contents

Survey of Forced and Precautionary Landing Costs

Introduction

What does it cost when an Army aircraft has a forced landing? What is the cost of a precautionary landing? The cost of these mishaps apparently has never been determined—at least a literature search and queries of knowledgeable individuals did not reveal a cost. This research did reveal that the costs associated with these mishaps are broad-based and obscure. Since forced and precautionary landings are free of aircraft damage and personnel injuries, they are without the convenience of cost determinants. This does not mean that forced and precautionary landing costs are unique. Costs must also be determined for accidents and incidents; however, aircraft damage and personnel injuries associated with these mishaps essentially eliminate the need to uncover obscure cost factors.

The items selected to elicit cost data will show costs are obscured regarding the effect forced and precautionary landings have on mission performance. Data were gathered in respect to (1) the effect these mishaps have on the mission assigned the aircraft involved, (2) man-hours lost by the crew and passengers, (3) man-hours required for the recovery operation, (4) hours the aircraft was unavailable for flight, (5) man-hours required to make the aircraft flyable, and (6) the relatively low cost of components that malfunctioned to cause many of these mishaps.

No assertive effort was made to determine the cost of the ripple effect that these mishaps have on the unit and their headquarters and the unit requesting support and their headquarters. These costs are probably more broad based and obscure and are suspected of being even greater than the costs of the items just mentioned.

This report will show that the aircraft components causing many of the forced and precautionary landings are relatively low cost, tend to have a malfunction/failure rate higher than expected, have a history of malfunction/failure, and have a measurable effect on aircraft reliability and availability. The ultimate effect of these mishaps is degradation of the unit's readiness posture.

This report must not be used in a manner that will discourage or even tend to discourage aviators from making forced or precautionary landings. Their judgment concerning when to execute either a forced landing or precautionary landing should not be adversely modified. The objective of this report is not to restrict aviators' use of these maneuvers but to reduce the need to rely on these maneuvers by avoiding the causes.

Background

There seems to be no one point in the recent history of Army aviation to begin this report. History shows the forced landing rate has remained essentially unchanged, while the precautionary landing rate has increased steadily. During the 11-year period of 1968-78 when Army aircraft flew more than 34 million hours and had more than 45,000 mishaps, forced landings accounted for 7.8 percent of the mishaps and occurred at a rate of 10.3/100,000 flying hours (hereafter, 100,000 flying hours will be omitted when rates are indicated), while precautionary landings accounted for 67 percent of the mishaps and occurred at a rate of 88.7. That experience was likewise reflected in the last year of the period, 1978, when Army aircraft flew 1.46 million hours and had 3,325 mishaps. For that year forced landings accounted for 3.7 percent of the mishaps and occurred at a rate of 8.3 while precautionary landings accounted for 94 percent of the mishaps and occurred at a rate of 213. From the data of figures 1 and 2, it is evident that these mishaps, particularly precautionary landings, show no indication of declining.

For this report, the experience of 1 January 1971 to 31 December 1978 will be used. The start of this period coincides with the date, generally agreed upon, that marked full implementation of the current mishap reporting system outlined in AR 95-5, Aircraft Accident Prevention, Investigation and Reporting. Much of the data used in this

report was derived from that source, i.e., the data obtained from the survey was combined with data retrieved from the computerized mishap files maintained by the Army Safety Center.

Figure 1, which is a combination of fixed wing and rotary wing experience, reveals a relationship between forced landings and accidents that has an effect on the accident rate and also focuses on the objective of this report. It can be interpreted from the data that the corrective measures taken to decrease accidents seemingly have not had a like effect on the causes of forced landings. Why is this? Are the causes of forced landings the same as or different from the causes of accidents? If their causes are the same, were the corrective measures taken against accident causes applied to the causes of forced landings and to what degree? If the causes of forced landings and accidents are different, what new and different measures are needed to prevent forced landings?

From the data in figure 1, it can be reasoned that the ability of Army aviators to cope with in-flight emergencies that cause forced landings is being maintained. Had this ability deteriorated, the accident rate would increase with each unsuccessful forced landing. The forced landings made during survey period 1 March-10 October 1978 were examined to test the reliability of this observation. No change in the aviators' ability was indicated. Of 75 reported in-flight emergencies, 57 (75 percent) of the forced landings were successful, i.e., autorotations were made with no damage to aircraft. Figures 1A and 2A, appendix A, compare the forced landing and accident rates for rotary wing and fixed wing aircraft.

Army Safety Center records show that precautionary landings were first recorded officially in September 1963. Records have since shown the precautionary landing rate to be many times greater than the forced landing rate and that the precautionary landing rate has steadily increased (see figure 2). At the beginning of CY 1971, the precautionary landing rate was 72. Precautionary landings have increased at a rate of 3.64 per quarter for a three-fold increase to a rate of 205 at the close of CY 1978. Much of the quarterly increase, in addition to change in reporting criteria that began early in 1978, was due to the increase in the fixed wing precautionary landing rate. The fixed wing increase was 4.4 per quarter in comparison to 3.5 for rotary wing aircraft shown in figures 1B and 2B of appendix A. An explanation of this finding was not pursued. However, figure 2B shows that much of the fixed wing difference may be attributable to an increase that began early in 1974 and lasted until early in 1976.

The discussion thus far and the data contained in the figures reveal the chronic nature of forced and precautionary landings. These data show that though the forced landing rate is much lower than the precautionary landing rate, the potential for an

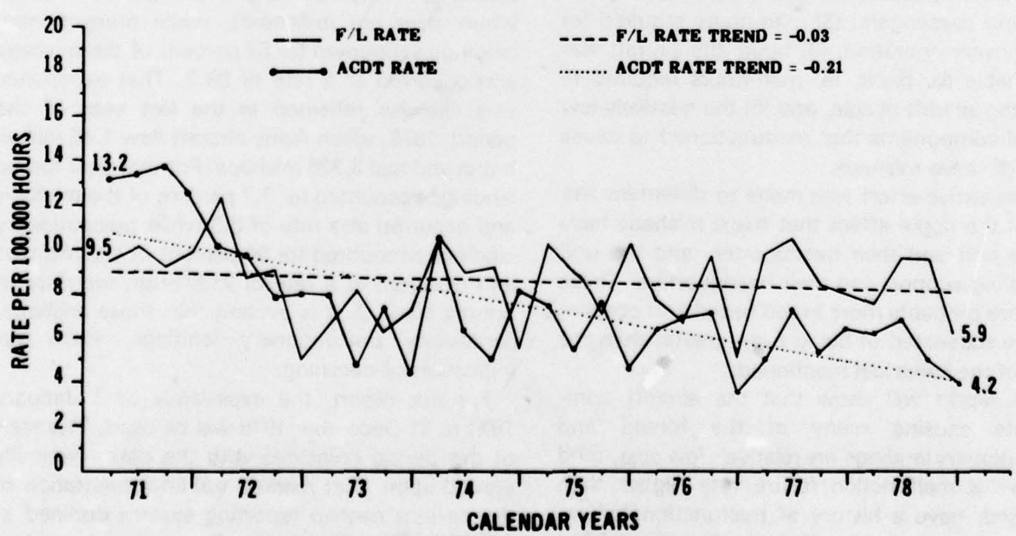


FIGURE 1.–Accident Rate vs. Forced Landing Rate

accident is obviously much greater with forced landings. Precautionary landings, however, because of their much higher rate, make up much of this difference in accident potential. Therefore, which of these mishaps have the greatest impact on mission performance is debatable. However, for purposes of this report, that question need not be answered at this time.

Many reasons could be offered as to why forced landings and particularly precautionary landings have been allowed to continue essentially unabated. One such reason is economics, i.e., dollar losses are not directly related to these mishaps. The accident potential of these mishaps apparently has not been great enough to attract needed attention. Motivation has also been lacking because, by definition, these mishaps are not accidents. Their occurrence is not used to calculate the rates that measure safety performance. Another equally cogent reason is the attitude that has evolved toward these mishaps. It is an attitude of approval—and rightly so. The basis for this attitude appears to be the fact that when one of these mishaps occurs, especially a successful forced landing, an accident is prevented, achieving the ultimate goal of safety, i.e., conservation of resources.

Method

Data for this report were obtained from a questionnaire survey conducted 1 March-10 October 1978 and from the Army Safety Center computerized aviation mishap file.

A one-page questionnaire (appendix A) was designed to elicit "cost" data in respect to (1) effect each mishap had on the mission assigned the aircraft involved, (2) man-hours lost by the crew and passengers, (3) man-hours required to recover the crew, passengers, and aircraft, (4) time the mishap aircraft was unavailable for flight (5) man-hours required to make the aircraft flyable, and (6) the components that malfunctioned to cause these mishaps.

Initially, the survey was to be limited to aviation units within FORSCOM. FORSCOM HQs had been briefed on the project, participated in the development of the questionnaire, and provided the addresses of their aviation units. Questionnaires were mailed to the FORSCOM units in late February 1978.

Because of the interest shown in the project, participation was then opened to aviation units Army-wide, and questionnaires were mailed upon request. Also, a reproducible "tear-out" copy was included in FLIGHTFAX. Fort Rucker was excluded from the survey to avoid the possibility of difference in "cost" that may exist between operational units and the highly structured school environment.

Aviation units were told that completion of the

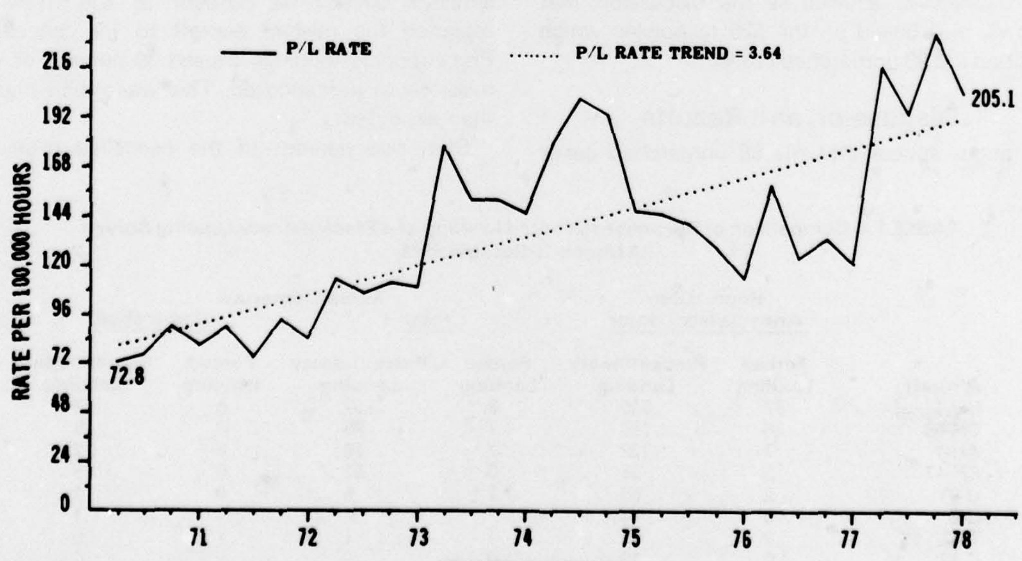


FIGURE 2.–Precautionary Landing Rate

questionnaire did not relieve them of the AR 385-40 requirement to report forced landings and precautionary landings on a Preliminary Report of Aircraft Mishap (PRAM). The units were also asked to complete a questionnaire for the forced and precautionary landings that did not meet reporting criteria of AR 385-40.

The first questionnaire received was of a precautionary landing that occurred on 1 March 1978. The last response accepted was of a precautionary landing that occurred on 10 October 1978.

Of the 520 questionnaires accepted, 26 concerned forced landings and 494 concerned precautionary landings. The responses were computerized and then matched with PRAMs of forced landings and precautionary landings received during the survey period. The results of this process are shown in table 1. Only those types of aircraft reported by the survey to have had a forced landing or precautionary landing are included in the table.

PRAMs for 82 forced landings and 1,636 precautionary landings, less Fort Rucker occurrences, were received during the survey period. The matched responses represent a sample of 32 percent of the 82 forced landings and 30 percent of the 1,636 precautionary landings. A match was not obtained for one forced landing and 97 precautionary landings.

The analysis, as well as the discussion that follows, was based on the 520 responses which included the 98 unmatched cases.

Discussion and Results

It might appear that the 98 unmatched cases may be invalid for purposes of this report and that the precautionary landing rates cited in the figures should be higher.

The unreported cases were anticipated and provided for by item F of the questionnaire. Validity of these cases is established by the fact that they were found to be not unique and that their cost factors were in line with the reported cases.

By regulation, however, not all the 97 precautionary landings had to be reported. Fifty-six precautionary landings fell into this category because of a February 1976 revision to AR 385-40 which stated that illumination of the chip detector light will be reported only when the component activating the light is replaced. Because a variation in interpretation can be made of the reporting criteria, a clear-cut case could not be made that all of the remaining 41 precautionary landings should have been reported. Assuming that half of them should have been, the rates shown would not change significantly because of the relatively small number.

Of the items included in the questionnaire, none were more revealing of the impact (cost) these mishaps have on mission performance than item H. Data of table 2, arranged in a matrix format, show the effect of these mishaps in combination. Most importantly, these data show that forced landings caused 42 percent of the missions assigned the mishap aircraft to be cancelled. Precautionary landings caused 39 percent of the missions to be cancelled. This was much higher than expected.

Sixty-two percent of the cancelled missions

TABLE 1.—Comparison of Response to Forced Landing and Precautionary Landing Survey 1 March-10 October 1978

	Reported to Army Safety Center		Survey Reported: Total		Survey Reported: Unmatched	
Aircraft	Forced Landing	Precautionary Landing	Forced Landing	Precautionary Landing	Forced Landing	Precautionary Landing
UH-1	37	515	9	257	0	42
OH-58	26	190	7	85	0	25
AH-1	7	122	7	76	0	12
CH-47	3	95	0	51	0	15
U-21	2	55	2	8	0	1
U-8	0	44	-	6	-	1
T-42	0	17	1	1	1	0
C-12	0	13	0	8	-	0
U-3	0	7	0	4	-	1
	75	1,058	26	494	1	97

were training, 33 percent were support, and 5 percent were test flights. Indications of the ripple effect of these mishaps were also revealed. Table 2 shows that of the 203 missions that were cancelled, 3 had been delayed less than an hour, 15 had been delayed more than an hour, 6 were assigned to another aircraft, and 7 required another mode of travel to be used.

TABLE 2.—Simultaneous Occurrence Matrix of Effect of Forced Landings and Precautionary Landings On Mission of the Mishap Aircraft

	F/L	P/L						
Forced landing	26							
Precautionary Landing	0	494						
Delayed <1 hour	4	103	107					
Delayed >1 hour	5	107	0	112				
Cancelled	11	192	3	15	203			
Used another aircraft	7	116	7	33	6	123		
Used same aircraft but at later date	1	12	0	2	0	0	13	
Used other mode of transportation	2	10	0	3	7	0	0	12

A similar indication of this effect is that for about 24 percent of the cases the mission of the mishap aircraft was carried out by another aircraft. In addition to the interruptions of training and logistical schedules, delays, personnel turbulence, etc., common to such situations, in 22 percent of the cases the mission was delayed more than an hour and it made little difference whether the mishap was a forced landing or a precautionary landing. Twenty-seven percent of the forced landings and 23 percent of the precautionary landings required a second aircraft to be readied fro the mission.

Applying the data of table 2 to the forced landings and precautionary landings that occurred since CY 1971 gives the cost of these mishaps over the 8-year period (table 3). During this time when more than 21,000 forced and precautionary landings occurred, more than 8,000 missions were probably cancelled and an additional 5,000 aircraft had to be made ready to carry out these missions. Unless preventive measures are applied to the causes of these mishaps, the potential losses shown for the past 8 years can be expected to increase in the future.

The survey revealed that when a forced or precautionary landing occurs, the personnel aboard the aircraft can expect to lose an average of 2.5 man-hours. Response to item J of the questionnaire showed that for the 520 cases, 1,292 man-hours were lost. Of this total, aviators accounted for 81 percent, non-rated crew accounted for 14.6 percent, and the passengers aboard the aircraft accounted for the remaining 4.4 percent.

These losses, applied to the data of table 3, show that for the 8-year period, 52,600 man-hours were probably lost. This loss translates to an annual loss of 6,565 man-hours or 3.2 man-years. The aviator loss was equivalent to the services of approximately 2.6 aviators per year.

As expected, man-hours that were lost tended to vary with the effect the mishap had on the mission. This variance by the personnel aboard the aircraft is shown in table 4. For example, lost time of aviators increases about fivefold when the mission is delayed more than an hour than when the delay is less than an hour. An equally costly loss occurs when it becomes necessary to use another mode of travel.

Forced landings and precautionary landings also cause the services of the aircraft to be lost. Response to item J of the questionnaire revealed that the aircraft involved were unavailable for flight for a total of 23,000 hours. The average per aircraft was 44 ±5 hours.

TABLE 3.—The Potential Effect of 8 Years of Forced Landings and Precautionary Landings On Mission Performance

	TOTAL		Delayed less than 1 hour		Delayed more than 1 hour		Cancelled		Performed by another aircraft		Rescheduled same aircraft at later date		Used other mode of transportation	
CY	F/L	P/L	F/L	P/L	F/L	P/L	F/L	P/L	F/L	P/L	F/L	P/L	F/L	P/L
78	122	3,120	20	636	24	655	54	1,236	34	733	5	62	10	65
77	138	2,022	22	412	28	425	61	801	39	475	6	40	11	42
76	107	1,933	17	394	21	406	47	765	30	454	4	39	9	39
75	134	2,698	21	550	27	567	59	1,068	38	634	5	54	11	54
74	133	2,439	21	498	27	512	59	966	37	573	5	49	11	49
73	132	2,038	21	416	26	428	58	807	37	479	5	41	11	41
72	217	2,064	35	421	43	433	95	817	61	485	9	41	17	41
71	405	3,338	65	681	81	701	178	1,322	113	784	16	67	32	67
	1,388	19,652	222	4,008	277	4,127	611	7,782	389	4,618	54	393	112	393

This loss is put in perspective in table 5. For that purpose the forced landing and precautionary landing experience of aircraft listed in table 1 and found in table 1.5 of FM 101-20 is used. It should be mentioned that these aircraft were involved in 88 percent of the mishaps reported Army-wide for the year. Of the 2,845 mishaps indicated, 96 percent were precautionary landings.

Based on the 44-hour average, the survey found UH-1s, for example, were unavailable for flight for more than 66,000 hours. This loss in flight hours annually allocated is equal to the hours allotted to more than 200 UH-1s. Had CY 1978 been a combat period, the allocation would be equivalent to the hours allotted to 69 UH-1s. These same kinds of observations can be made for the other aircraft listed.

The potential cost of the nonavailability of aircraft because of these mishaps becomes more apparent when it is realized that the more than 3,200 forced and precautionary landings reported in 1978 denied the potential availability of more than 500 aircraft. Had this been a time of combat, the denial would have been equivalent to approximately 170 aircraft. The dollar cost of the aircraft made idle for this reason runs into the millions.

As large as the 44-hour average loss appears to be, it is important to mention that 50 percent of the aircraft were unavailable for flight 3 hours or less, and 19 percent were unavailable for 1 hour or less. Countering these times, however, approximately 20 percent were down for more than the 44-hour average. About 2 percent of this 20 percent were down more than 700 hours, or almost 30 days.

When a forced landing or precautionary landing occurs, the personnel, facilities, services, etc.,

TABLE 4. — Man-Hours Lost by Personnel Aboard Per Forced Landing and Precautionary Landing

Effect of Mishap on Mission	Aviators Hrs. Minutes	Median Nonrated Crew Hrs. Minutes	Passengers Hrs. Minutes
Delayed <1 hour	0:52	0:39	0:32
Delayed >1 hour	4:15	0:44	0:40
Cancelled	1:05	0:38	0:33
Used Another Aircraft	1:58	0:41	0:39
Used Same Aircraft But at Later Date	1:30	0:41	0:35
Used Other Mode of Transportation	4:00	1:00	0:59

TABLE 5. — CY 1978 Aircraft Equivalent Losses Attributable to Forced and Precautionary Landings

Aircraft	No. of F/Ls + P/Ls	Hrs Acft* Unavailable	Unavailable** Acft Equivalent Noncombat	Combat
UH-1	1,506	66,264	220.9	69.0
OH-58	531	23,364	97.4	32.5
AH-1	254	11,176	46.6	13.3
CH-47	250	11,000	45.8	15.3
U-21	118	5,192	12.4	5.8
OV-1	93	4,093	17.1	5.6
U-8	59	2,596	7.2	2.9
T-42	34	1,496	2.5***	2.5
	2,845	125,120		

*No. of forced landings + precautionary landings X 44 hrs average/mishap.
**Hours aircraft unavailable ÷ flying hour planning factor, table 1.5, FM 101-20.
***Indirect support.

required to recover and make the aircraft flyable are generally provided at the expense of scheduled ongoing operations. An indication of this expense, derived from the responses to item K, is seen in table 6, which shows the requirements for personnel in combination. Unit maintenance personnel were required for about 80 percent of the cases. Field maintenance and other personnel were required for approximately 10 percent of the cases.

TABLE 6.—Simultaneous Occurrence Matrix of Inspection/Repair of Mishap Aircraft at Mishap Site

Performed by	F/L	P/L				
Crew assigned aircraft	6	145	151			
Unit Maintenance Personnel	19	392	98	411		
Field Maintenance Personnel	4	40	10	16	44	
Personnel from Other than Established Support	2	10	6	5	1	12

These data are limited in their ability to show the more obscure costs produced by the need, which is generally urgent, to attend to downed aircraft. These costs are known to reveal themselves in a variety of forms, of which flight safety is but one. Delays and interruptions as a result of forced and precautionary landings cause plans to be changed, new plans to be made, and planning to be done hurriedly, and are frequently cited by accident investigators.

The requirement for personnel and services at the expense of ongoing operations continues through the recovery of the aircraft and crew. Table 7 shows the means of recovery, personnel used for the recovery, and the location of the mishap. Note that the response to item L shown in parentheses is greater than column data. This was because the locations of all the previously mentioned unmatched cases, shown in table 1, were not reported.

Note that recovery was not required in 51 percent of the cases. A reason for this much greater than expected percentage is probably because a majority of the current flying is done within the confines of a post and most often, as indicated by table 7, within reach of an airfield. A more important reason, however, is that 95 percent of these mishaps were precautionary landings, which means continued flight to a suitable site was the most prudent action to take. Costs reflected in table 7, therefore, are not indicative of the costs likely to be incurred during a period of combat. Data of CY 1971, the last year of the Southeast Asia operations, showed that the number of forced and precautionary landings occurring off post, off an airfield was much greater. This should be a matter of concern to the resource managers and planners. For that year, 62 percent of the forced landings and 45 percent of the precautionary landings were on post, off an airfield compared to 41 percent and 27 percent, respectively, for CY 1978.

These data reveal another equally real need to prevent the causes of these mishaps. Table 7 indicates accidents tend to be avoided when suitable landing sites are available. Therefore, steps taken to prevent the causes of these mishaps will also help prevent accidents.

The survey found that, on an average, recovery operations required 14 hours for completion. The response made to item M indicated that for the 270 mishap aircraft recovered, more than 3,800

TABLE 7.—Aircraft Recovery by Mishap Location

Location of Mishap	Recovery Not Needed	Flown by Acft Crew	Flown by Maint Crew	Airlifted	Surface Vehicle
On Post, on Airfield	111	16	18	1	7
On Post, off Airfield	36	20	30	2	1
On Airfield, Other Service	27	4	2	0	2
On Civil Airfield	7	8	14	0	0
Off Post, Off Airfield	23	35	35	1	6
No.	204	83	99	4	16
Response to Item L No.	(250)	(112)	(114)	(4)	(17)
%	(51.0)	(23.0)	(23.0)	(0.8)	(3.4)

hours, or approximately 14 hours per recovery, were needed. Probably because of the location of these mishaps, 50 percent of the recoveries were made in 2 hours or less. Only 25 percent of the recoveries required 5 or more hours. However, 3 percent of the recoveries required more than 100 hours. The maximum recovery time reported was 720 hours. These findings, applied to the more than 21,000 forced and precautionary landings of table 3, reveal that more than 150,000 hours were spent in recovery of the mishap aircraft.

When required for recovery, maintenance personnel, indicated in table 6, were used an average of 8 hours per operation. The response to item N indicated that more than 2,000 maintenance hours were used. Fifty percent of these cases required two or less man-hours, which is reasonable because of the minor nature of the malfunctions generally associated with these mishaps. Only 25 percent of the recoveries required more than 7 man-hours. Also, as an indication of the minimum amount of maintenance/repair done at the mishap site, only 1 percent of the operations required more than 100 hours. The maximum number of hours reported was 256. Again, applying these findings to data of table 3 reveals that proportionately the services of more than 9,800 maintenance personnel were required. Their services amounted to more than 78,000 man-hours, or 38.7 man-years.

Services of operations personnel were required for 18 percent of the recovery operations. For these cases, an average of 5 man-hours was used, while 50 percent needed the use of operations personnel for only 1½ man-hours or less.

Services of security personnel were required in less than 4 percent of the cases. This small percentage can be viewed as another reflection of the fact that these mishaps occur near needed facilities and services. For these few cases, however, an average of 35 man-hours was required, while 50 percent of the cases required 20 man-hours or less.

Services of medical personnel were required for only 1 percent of the recovery operations.

Thirty-two percent of the recovery operations involved the use of aircraft to transport personnel to and from the mishap site and for air transport of four aircraft indicated in table 7. Response to item 0 indicated that for these cases 280 flight hours were used for an average of 1 hour and 40 minutes. Fifty percent of these cases involved 52 minutes or less of flight time. Twenty-five percent of these recoveries required 2 hours or more. Less than 3 percent of these cases required more than 9 hours. The maximum number of flight hours used was 20.

The minimal amount of time surface vehicles were used during recovery operations also reflects the near ideal locations of these mishaps. Surface vehicles were reported to be used for 11 percent of the recoveries (57 cases), averaging about 2 hours per recovery. In half of the recoveries, the vehicle was used 56 minutes or less. Twenty-five percent of the recoveries required about 2 hours of vehicle use.

It was previously mentioned in this report that the components that cause forced and precautionary landings have a history of malfunction/failure and are relatively low-value items, and many have the capacity to cause mishaps more severe than forced landings and precautionary landings. These earlier observations were confirmed by the survey.

Of the 423 survey cases that were also reported in compliance with AR 385-40, 245 (58 percent) cited materiel malfunction as the cause.

Of the 245 cases, 159 different components that malfunctioned were identified. Maintenance, to indicate its role in these mishaps, was cited as a factor in 3 forced landings and 39 precautionary landings, or 16 percent of the cases in which materiel was a factor.

To obtain the date of the first time each component was reported in a mishap, the number of times each component was reported, and the class of mishap that resulted from each malfunction, the 245 cases were matched against the mishaps on file that had been reported during the period 1 January 1971 - 31 December 1978. The results of that process are shown in figure 3 and table 8 of the discussion and table 8A, Appendix A.

The malfunction/failure history is confirmed by the data in figure 3, which shows that 30 percent of the components identified by the survey were first reported in CY 1971 and that 62 percent of the components were reported for the first time during the first 4 years of the period. Considering that these components are from aircraft that became operational in the early and mid-1960s, the malfunction history of these components probably dates back further than indicated by figure 3.

Note in figure 3 that a surge of malfunctions reported for the first time occurred in CY 1978, the

last year shown. This surge, which occurred following a 6-year decline of first-time occurrences, involved 25 percent of the components. Examination of available data did not provide an acceptable explanation for the surge. All of the components are listed in table 8A, appendix A. A review will show that these components by general nomenclature are not unlike many of the listed components that have a longer history of failure. To prevent these components from accruing a long history of failure, this finding suggests that the components, their mode of failure, and the servicing and maintenance they require should be investigated further.

The capacity of these components to cause more severe mishaps was revealed by 16 components that caused 168 of the 204 forced landings. These components were also involved in 27 accidents and 1,085 precautionary landings for this period, as shown in table 8A.

Involvement of this magnitude by relatively few components suggests that improvements made to these components could do much toward preventing the causes of a significant number of forced and precautionary landings, as well as many accidents.

The relatively low cost of these components, as shown in table 8A, was likewise confirmed. Twenty-five percent of the listed components that contributed annually for the past 8 years to more than 500 mishaps cost not more than $45, 50 percent were components that cost $165 or less, and 75 percent were components that cost not more than $555. The relatively low cost of these components is perhaps an indication that cost of improvements should not be excessive. It is reasonable, for example, to assume that the cost to improve the pressure switch, which costs $34.16 and was named in 305 mishaps, should not be inordinately high. The fix in this case might be nothing more than ruggedizing the pressure switch to withstand the vibrations peculiar to

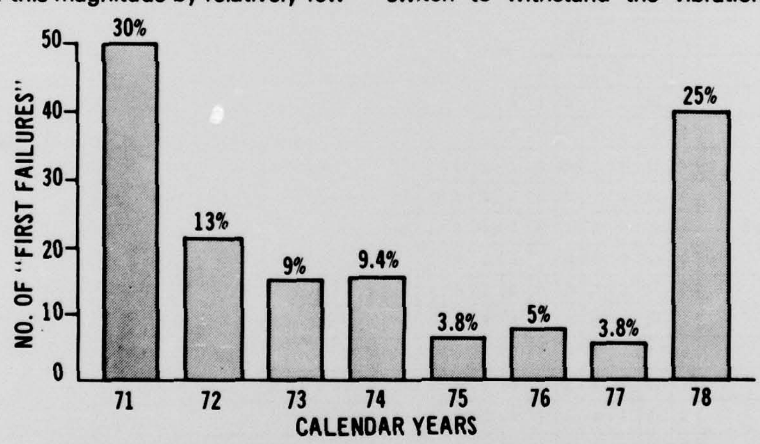


FIGURE 3.—Year Component Failure First Reported Since 1 January 1971

TABLE 8.—Mishap History and Cost of 159 Components Reported by Survey*
1 January 1971-31 December 1978

National Stock No.	No. of Occurrences	Date of 1st Occurrence	Nomenclature	Cost**	No. of Survey Occurrences	Occurrences by Mishap Acdt	Incd	F/L	P/L	Other
1. 6140 00 753 2251	440	710205	Battery	554.00	14	2	3	4	431	0
2. 5930 00 646 3495	311	710107	Pressure Switch	34.16	5	0	0	0	311	0
3. 6620 00 179 1886	187	710414	Generator Tach	104.00	6	1	0	0	186	0
4. 6620 00 586 1503	185	710206	Indicator Press	46.27	4	1	0	4	180	0
5. 4810 00 130 5964	157	720421	Valve Irreversible	.00	2	0	2	0	155	0
158. 1680 00 491 9766	1	780917	Sensing Element Fire Det	163.00	1	0	0	0	1	0
159. 1680 00 478 6018	1	780518	Panel Indicator	275.00	1	0	0	0	1	0
	4,404				245	38	24	205	4,135	2

*For complete table, see Table 8A, Appendix A.
**Sources Army Master Data File
Catalog Data Agency, New Cumberland, PA

rotary wing aircraft. The failure of these pressure switches, pressure transmitters, and transducers—whose cost averaged $72 per item—reported in 698 mishaps and submerged fuel pumps—with a cost averaging less than $330—named in 226 mishaps are other examples found in table 8A.

Early in the development of the questionnaire, a request was made to gather the indications which alerted the crew to the condition of the aircraft that led to the forced landing or precautionary landing. Item G of the questionnaire was designed for that purpose. The response to item G is shown in table 9.

Instructions for item G were to select one or more of the choices that would best describe the alerting means. Note that item G of the questionnaire contained 26 choices including "other" and "no indication," while table 9 shows the response to 30 choices. The additional choices were derived from the respondent's explanation of "other," when it was selected.

The table is arranged to show the choices made for the 26 forced landings and 494 precautionary landings and the choices made in combination. For example, vibration alerted the crews of aircraft that made 2 forced landings and 26 precautionary landings. In addition, for these 28 cases, 15

TABLE 9.—Occurrence Matrix of Indicators/Indications That Alerted Crew of Condition Leading to 26 Forced Landings and 494 Precautionary Landings

Forced Landing	26																															
Precautionary Landing	0	494																														
Vibration	2	26	28																													
Unusual Noise	6	58	15	64																												
Unusual Attitude	5	15	1	4	20																											
Faulty Operation–Aircraft	3	61	9	9	1	64																										
Odor	0	34	0	1	0	1	34																									
Fluid Leakage	2	30	0	0	0	0	9	32																								
Smoke or Fire	0	13	1	2	0	0	7	2	13																							
Other Personnel	0	14	1	1	0	0	2	0	3	14																						
Master Warning/Caution Light	7	149	4	9	2	5	2	2	0	1	156																					
Annunciator Panel	0	11	0	0	0	1	1	0	0	0	9	11																				
Voice Warning	0	2	0	0	0	0	0	1	0	1	0	0	2																			
Fire Warning Light	1	10	0	0	0	0	0	0	0	0	0	0	0	11																		
Warning Horn	0	1	0	0	0	1	0	0	0	0	0	0	0	0	1																	
RPM Warning–Light	6	22	4	5	4	4	0	0	0	0	6	0	0	0	1	28																
RPM Warning–Audio	8	16	4	4	6	3	0	0	0	0	4	0	0	0	1	22	24															
RPM Warning–Tachometer	5	23	2	7	3	4	0	0	0	0	5	0	0	0	1	13	11	28														
Chip Detector–Engine	1	49	0	2	1	1	0	0	0	2	30	3	0	0	0	2	1	1	50													
Chip Detector–Transmission (main)	0	13	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	13												
Chip Detector–Gearbox	0	16	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	1	0	16											
Instruments–Fuel	1	4	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	1	1	0	0	5										
Instruments–Oil	2	41	1	0	0	5	0	1	0	0	7	0	0	0	0	0	0	0	0	0	0	0	43									
Instruments–Hydraulics	0	18	0	4	0	0	0	2	0	0	10	0	1	0	0	0	0	0	0	0	0	0	0	18								
Instruments–Landing Gear	0	5	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5							
Instruments–Electrical	0	13	0	1	0	0	7	1	2	1	3	1	0	0	0	0	0	1	0	0	0	0	0	0	0	13						
Visual	1	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11					
Torque Meter	0	15	1	2	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	15				
EGT/TOT	0	14	0	1	1	4	0	0	0	0	0	0	0	0	0	1	1	2	0	0	0	1	0	0	0	0	0	0	14			
N1/N2	1	8	0	2	1	4	0	0	0	0	2	0	0	0	0	1	1	2	1	0	0	1	0	0	0	0	0	2	5	9		
Pre-/Post-Flight	0	6	0	3	1	1	0	0	0	0	2	0	0	0	0	1	1	2	0	0	0	1	0	0	0	0	0	0	0	0	6	
No Indication	1	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	12

aviators were also alerted by an unusual noise, 1 by unusual attitude, 9 by the aircraft not operating normally, 1 by smoke/fire, etc. These choices reflect the experience of the aviators of the aircraft listed in table 1. Choices by aircraft or in combination are available. This information will be retained for approximately 3 years should there be a further need for it.

CONCLUSIONS

☐ The broad and obscure costs revealed by the survey are sufficient to justify the initiation of a concerted effort to prevent causes of these mishaps.

☐ Prevention of the causes of these mishaps will allow aviation units to operate more efficiently, i.e., allow them to maintain a higher state of combat readiness.

RECOMMENDATIONS

☐ That an assertive effort be made to turn back the long history of failure of a few relatively low-cost components that were involved in a disproportionately high number of forced and precautionary landings.

☐ That a similar history of failure of a few components not be allowed to occur in the next generation of aircraft, i.e., UTTAS, AAH, ASH.

APPENDIX A

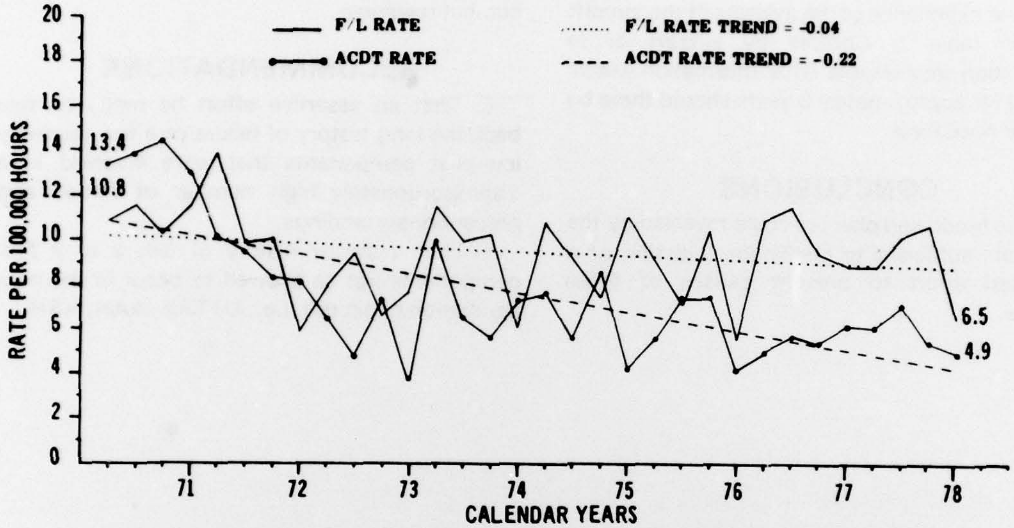


FIGURE 1A.–Rotary Wing Accident Rate vs. Forced Landing Rate

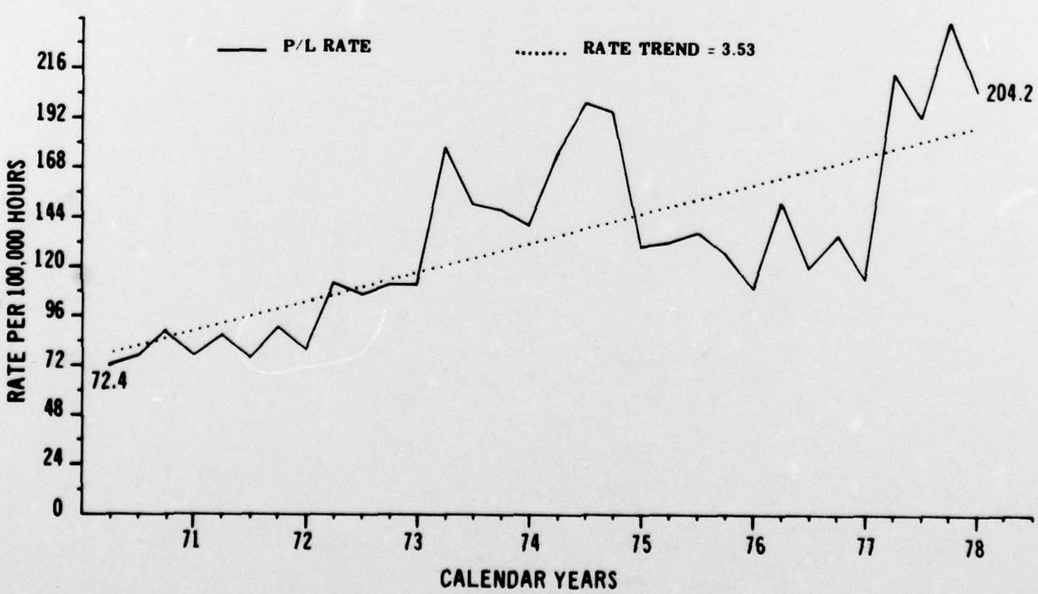


FIGURE 1B–Rotary Wing Precautionary Landing Rate

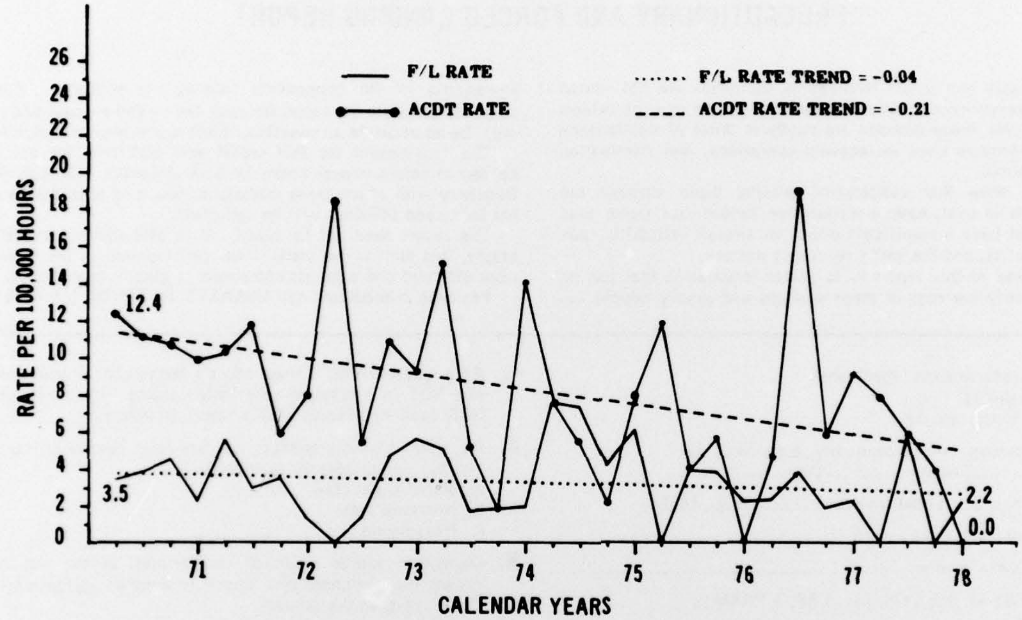


FIGURE 2A.–Fixed Wing Accident Rate vs. Forced Landing Rate

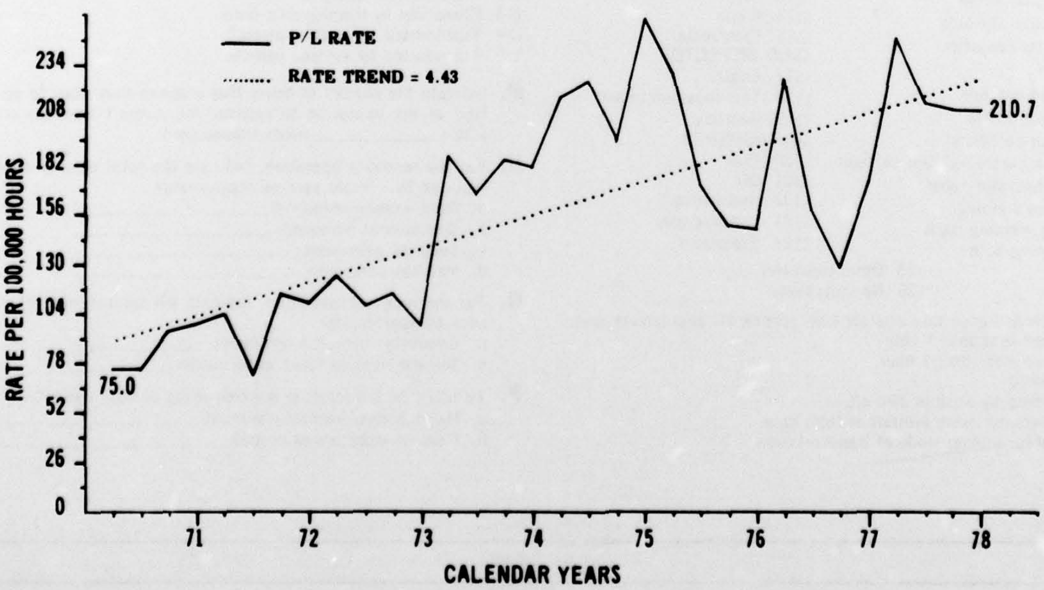


FIGURE 2B.–Fixed Wing Precautionary Landing Rate

USAAAVS

PRECAUTIONARY AND FORCED LANDING REPORT

Precautionary and forced landings by definition are not costed for mishap prevention purposes because damage and injuries seldom occur. However, these mishaps are costly in terms of maintenance manhours, manhours used in recovery operations, and interruption to unit operation.

Analyses show that components causing these mishaps are relatively low in cost, have a malfunction/failure rate higher than expected, and have a significant effect on aircraft reliability, aircraft availability, and the unit's readiness posture.

The purpose of this report is to gather information that can be used to quantify the cost of these mishaps and justify needed improvements in the components causing the mishaps. For this purpose, complete the report for each forced and precautionary landing. Be as accurate as possible. Each report will be computerized.

The requirement for this report will last only for the period needed to obtain enough cases for a valid sample. Considering the frequency with which these mishaps occur, it is estimated a period not to exceed 180 days will be sufficient.

The report need not be typed. It is self-addressed—just fold, staple, and drop in the mail. Your participation in the interest of more efficient and safer air operations is greatly appreciated.

For more information, call USAAAVS, AUTOVON 558-4510/4812.

A. Mishap classification (check one)
- ☐1 Forced landing
- ☐2 Precautionary landing

B. Date of mishap (enter numerically, e.g., 78 01 13)
Year ______ Month ________ Day ________

C. Time of mishap: Local time __________ (e.g., 1635)

D. Aircraft design model series ____________________________

E. Aircraft serial number ____________________________

F. IAW AR 385-40, Jan 1978, par. 5-8F, a PRAM is
- ☐1 Required
- ☐2 Not required

G. Check one or more from the indicators/indications below what first alerted the crew to the conditions leading to this mishap.

- ☐1 Vibration
- ☐2 Unusual noise
- ☐3 Unusual attitude
- ☐4 Faulty operation
- ☐5 Odor
- ☐6 Fluid leakage
- ☐7 Smoke or fire
- ☐8 Other personnel
- ☐9 Master warning/caution light
- ☐10 Annunciator panel
- ☐11 Voice warning
- ☐12 Fire warning light
- ☐13 Warning horn

RPM WARNING
- ☐14 Light
- ☐15 Audio
- ☐16 Tachometer

CHIP DETECTOR
- ☐17 Engine
- ☐18 Transmission (main)
- ☐19 Gearbox

INSTRUMENTS
- ☐20 Fuel
- ☐21 Oil
- ☐22 Hydraulics
- ☐23 Landing gear
- ☐24 Electrical

- ☐25 Other (specify)
- ☐26 No indication

H. Mission assigned this aircraft was: (check all appropriate ones)
- ☐1 Delayed less than 1 hour
- ☐2 Delayed more than 1 hour
- ☐3 Cancelled
- ☐4 Performed by another aircraft
- ☐5 Rescheduled same aircraft at later date
- ☐6 Assigned another mode of transportation

I. As a result of this mishap indicate the number of hours aircraft was NOT in a mission-ready (NOR) status. If aircraft remains NOR upon submission of this report, estimate.______________

J. As a result of this mishap, indicate total number of manhours lost by: (enter zero as appropriate)
- a. Rated flight crew ____________
- b. Nonrated crew ____________
- c. Passengers ____________

K. Inspection and/or repair of this aircraft at the site of the mishap was performed by: (check as many as appropriate)
- ☐1 Crew assigned the aircraft
- ☐2 Unit maintenance personnel
- ☐3 Field maintenance personnel
- ☐4 Personnel other than established support

L. Recovery of this aircraft from the mishap site was completed by:
- ☐1 Recovery not required
- ☐2 Flown out by assigned crew
- ☐3 Flown out by maintenance crew
- ☐4 Transported by another aircraft
- ☐5 Transported by surface vehicle

M. Indicate the number of hours that elapsed from start to completion of the operation to recover the aircraft from the mishap site: ____________hours lapsed time

N. For the recovery operation, indicate the total number manhours required by: (enter zero as appropriate)
- a. Maintenance personnel____________________
- b. Operational personnel____________________
- c. Security personnel____________________
- d. Medical personnel____________________

O. For the recovery operation, indicate the total number of: (enter zero as appropriate)
- a. Recovery aircraft flight hours ____________
- b. Surface vehicle hours of operation____________

P. To return this aircraft to mission-ready status, indicate:
- a. Maintenance manhours to repair____________________
- b. Cost of replacement part(s)____________________

Remarks:____

____

____

(Continue on back if necessary)

USAAAVS FORM 2-78, DATED 26 JANUARY 1978

TABLE 8A.—Mishap History and Cost of 159 Components Reported by Survey 1 January 1971-31 December 1978

NATIONAL STOCK NUM.	NO. OF OCCUR.	DATE - 1ST OCCURRENCE	NOMENCLATURE	COST	NO. OF OCCUR.	SURVEY OCCURRENCES BY MISHAP ACC	INC	FL	PL	OTH
6140007532251	440	710205	Battery	554.00	14	2	3	4	431	0
5930006463495	311	710107	Switch Pressure	34.16	5	0	0	0	311	0
6620001791886	187	710414	Generator Tachometer	104.00	6	1	0	0	186	0
6620005851503	185	710206	Indicator Pressure	46.27	4	1	0	4	180	0
4810001305964	157	720421	Valve, Irreversible	.00	2	0	2	0	155	0
2915009942016	148	710110	Governor Assy Overspeed	2750.00	3	6	5	27	109	1
2915007817917	144	710216	Fuel Control	9750.00	1	4	0	59	81	0
1615009182677	137	710102	Gear box assy, T/R	1538.00	5	2	1	0	134	0
6620000674946	130	710120	Xmitter Pressure	97.50	5	0	0	0	130	0
4730007862992	120	710607	Chip Detector	8.48	1	0	0	0	120	0
5330001075393	119	730327	Gasket	.84	1	0	0	4	115	0
1615001216543	94	710128	Xmission Assy, Main	7731.00	1	1	0	1	92	0
1650000142038	91	710228	Servo Cylinder	923.00	1	0	0	1	90	0
2915002237004	90	730820	Fuel Control	9750.00	8	2	1	20	67	0
5930007381640	84	710106	Switch	59.50	6	0	0	0	84	0
6110009976055	83	710618	Regulator Voltage	99.65	5	0	0	0	83	0
5930000769835	79	710813	Switch, Pressure	67.71	2	0	0	0	79	0
2915000128684	78	710202	Pump Submerged	510.00	1	0	1	2	75	0
5930001688019	69	710924	Switch, Pressure	59.50	1	0	0	0	69	0
1615004776304	68	711223	Chip detector, Xmsn	27.56	1	0	0	0	68	0
6125008659683	67	710120	Motor Generator	856.00	3	0	0	1	66	0
2915000180012	67	770810	Pump Submerged	220.00	7	0	0	0	67	0
2915001344564	60	710208	Fuel Control	875.00	2	1	0	24	34	1
6340006279180	56	710329	Control, alarm	121.23	2	0	0	0	56	0
6685005809651	55	710420	Xmitter	19.42	3	0	0	0	55	0
2915009993705	54	710225	Pump Submerged	220.00	2	0	0	0	54	0
5330008052966	53	710128	Packing Preformed	.02	1	0	0	0	53	0
1615009182676	50	710117	Gearbox Assy T/R	1144.00	1	0	1	2	47	0
5930001794546	46	710803	Switch, Pressure	28.19	3	0	0	0	46	0
2925000813547	46	750306	Starter Generator	1200.00	2	0	0	0	46	0
2840009248648	44	720103	Actuator Assy IGV	527.00	1	0	1	5	38	0
2840009495456	40	710119	Actuator Assy, Bleed	540.00	3	1	0	4	35	0
1650001305964	32	710105	Valve, Irreversible	.00	1	3	0	0	29	0
6685005570370	32	710130	Indicator Temperature	94.51	2	0	0	0	32	0
1680009098716	30	721114	Brake Assy, Magnetic	166.00	1	0	0	0	30	0
2915000179021	29	740501	Pump Submerged	220.00	1	0	0	0	29	0
5930001563315	28	720227	Switch, Pressure	53.55	1	0	0	0	28	0
4730007732621	26	710224	Coupling Half Quick Disc	52.90	1	0	0	1	25	0
6620005751427	26	770615	Thermostat	80.00	2	0	0	0	26	0
6680008410302	26	710907	Indicator Tachometer	187.00	3	3	0	0	23	0
6140009800025	23	710216	Battery	523.00	1	0	0	0	23	0
1615001724508	23	740717	Chain Assy, Silent	223.00	4	2	2	10	9	0
5330008080794	22	710322	Packing, Preformed	.03	1	0	0	0	22	0
5930008688474	22	720326	Switch, Pressure	26.98	1	0	0	0	22	0
6680001830374	22	720817	Transducer Pressure	644.00	1	0	0	0	22	0
6140002288447	21	730608	Battery	508.00	1	0	0	0	21	0
1615004322492	19	740315	Gearbox Rotary	1350.00	1	1	0	0	18	0
4730001654904	19	720608	Elbow Assy	101.68	1	0	0	1	18	0
3110000714568	17	710224	Bearing Roller	127.00	1	0	1	2	14	0
2995009903163	16	720906	Actuator Linear	149.00	2	0	0	1	15	0
2925005555349	16	710804	Relay, Generator	118.87	1	0	0	0	16	0

TABLE 8A continued

5930009925364	16	710121	Switch, Toggle	23.40	1	0	0	0	16	0
4720008685799	15	710320	Hose, Assy	11.68	1	0	0	0	15	0
2840001763780	15	710218	Blade, Compressor	25.78	2	2	0	6	7	0
1680008959427	13	710607	Element, Sensing	130.00	1	0	0	0	13	0
3020007658566	13	711203	Gear, Spur	57.90	1	0	0	0	13	0
2915004539569	13	710803	Valve Assy, Bleed	326.00	1	1	0	3	9	0
5935002630213	13	731213	Connector Plug	9.19	1	0	0	1	12	0
5330007534432	13	731213	Seal Plain Encased	1.22	1	0	0	0	13	0
1650009124122	11	710131	Servo Cylinder	176.00	1	0	0	0	11	0
2810001571814	10	730320	Cylinder, Piston	654.00	1	0	0	0	10	0
4320001345197	10	760823	Pump Axial Piston	714.00	1	0	0	0	10	0
5935001060096	10	721027	Adapter Connector	60.06	1	0	0	0	10	0
5945004008297	10	730308	Solenoid, Electrical	37.50	2	0	0	7	3	0
5330001514238	10	720507	Seal, Plain Encased	13.96	2	0	0	0	10	0
1615000791007	10	760520	Xmission	26500.00	1	0	0	1	9	0
6685001792248	10	720524	Indicator, Oil Temp	265.04	1	0	0	0	10	0
3110008726968	9	720621	Bearing, Ball	30.17	1	0	0	0	9	0
2915001569941	9	730411	Pump Fuel Metering	901.00	1	0	0	0	9	0
4730001422155	8	740301	Nipple, Tube	.23	1	0	0	0	8	0
5930008426470	8	710323	Switch, Limit	44.56	1	0	0	1	7	0
5330008111445	8	740317	Packing, Preformed	.07	2	1	0	0	7	0
5330008605611	7	760823	Seal, Plain Encased	9.77	1	0	0	0	7	0
5930008776666	7	710510	Switch, Pressure	99.51	1	0	0	0	7	0
5330002651088	7	720427	Packing Preformed	.04	1	0	0	0	7	0
4820009069236	7	730807	Valve, Thermal	21.26	1	0	0	0	7	0
6340007590710	7	731018	Indicator, Fire	31.17	2	0	0	0	7	0
4820006268108	7	770907	Valve, Check	170.00	2	0	0	3	4	0
6680001811955	7	740529	Indicator Liquid Quantity	297.00	1	0	0	0	7	0
1615005709765	7	721010	Valve, Assy Oil	1167.00	1	0	0	0	7	0
1650000119022	6	711028	Servo Cylinder	1052.00	1	0	0	0	6	0
4320001761261	6	750424	Pump Axial Piston	756.00	1	0	0	0	6	0
2995001505915	6	750320	Box, Assy Engine Control	3439.00	1	0	0	0	6	0
6110004786018	6	741009	Panel Fault	.00	1	0	0	0	6	0
5935008497173	6	741004	Connector	7.31	1	1	0	0	5	0
5935008134716	6	710602	Connector Plug	2.81	1	0	0	0	6	0
6130001688544	5	780307	Inverter	342.00	1	0	0	0	5	0
5320000620099	5	720921	Rivet, Solid	3.08	1	0	0	0	5	0
5330009473205	5	761206	Seal Plain Encased	.59	1	0	0	0	5	0
2995008605550	5	740311	**Actuator	.00	1	0	0	0	5	0
3110004261193	5	721004	Bearing, Ball	50.57	1	1	0	2	2	0
3110009130593	5	740311	Bearing, Ball	1.94	1	0	0	1	4	0
2915009686363	5	710802	Switch Float, Liquid	24.58	1	0	0	0	5	0
4710010043780	5	780227	Hose	.00	2	0	0	2	3	0
2915009124522	5	740924	Pump Elect Motor Driven	220.00	1	0	0	0	5	0
1680008354848	5	780301	Panel, Fault	275.00	1	0	0	0	5	0
1560004713329	5	720525	Door, Emergency Acft	2414.00	1	0	3	0	2	0
1560009218559	4	710114	Suspension, Assy Cargo	1870.00	1	0	0	0	4	0
2810007951078	4	720404	Ring, Piston	5.13	1	0	0	0	4	0
1650010149332	4	780828	Servo Cylinder	850.00	1	0	0	0	4	0
2840009254145	4	730322	Panel Assy	63.22	1	0	0	0	4	0
4710009259212	4	780411	Tube Assy	8.60	1	1	0	1	2	0
4320001287429	4	770228	Pump	3421.00	1	0	0	0	4	0
5330005769925	4	711223	Packing Preformed	.03	1	0	0	0	4	0
5330002638032	4	750429	Packing Preformed	.04	1	0	0	0	4	0
6105006696434	4	730702	Motor D.C.	199.29	1	0	0	0	4	0
1615008156682	4	721219	Housing, T/R Quill	11.59	1	0	0	0	4	0
1560009990308	3	780822	Window Panel	117.00	1	0	0	0	3	0
1615001690360	3	740725	Blower Unit, Rotary	353.00	1	0	1	0	2	0

5930009550581	3	720120	Switch Toggle	11.80	1	0	0	1	2	0
5310002085769	3	761110	Nut, Hex, Plain	.14	1	0	0	1	2	0
6240005573065	3	741113	Lamp Incandescent	8.50	1	1	0	0	2	0
4320000646515	3	771113	Pump Axial Piston	819.00	1	0	0	0	3	0
2840009489351	3	731005	Band Compressor	1.07	1	0	0	0	3	0
2840009489358	3	750324	Band Compressor	2.79	1	0	0	0	3	0
1680008959426	3	750318	Sensing Element	66.35	1	0	0	0	3	0
1680009215992	2	780921	Brake Magnetic	166.00	1	0	0	0	2	0
2915006471666	2	720110	Valve, Bleed Air	3.81	1	0	0	1	1	0
4730008108828	2	740702	Nipple, Tube	2.88	1	0	0	0	2	0
4720009581318	2	780331	Hose, Assy	7.31	1	0	0	0	2	0
4730005809165	2	761115	Nipple, Tube	.41	1	0	0	0	2	0
6110001116828	2	770526	Generator, Elect	.00	1	0	0	0	2	0
5310009618390	2	730523	Nut Hex Self Locking	.20	1	0	1	0	1	0
5330000679994	2	760225	Packing Preformed	.16	1	0	0	0	2	0
564[illegible]0100393	2	740612	Blanket, Sound Absorbing	42.83	1	0	1	0	1	0
161500135[illegible]	2	751121	Hub Assy Rotor	1761.00	1	0	0	1	1	0
1615008959456	2	761026	Retainer, Oil Seal	33.92	1	0	0	0	2	0
1090000748878	2	780324	Drive, Assy	1427.00	1	0	0	0	2	0
1560007773326	1	780914	Retainer, Hinge Pin	4.49	1	0	0	0	1	0
1560001814169	1	78[illegible]03	Cover, Drive Shaft	41.42	1	0	0	0	1	0
6620001795187	1	780321	Switch	.00	1	0	0	0	1	0
1615007392580	1	780524	Sha[illegible] Assy Xmission	580.00	1	0	0	0	1	0
1615010100952	1	780811	Xmission Assy	40996.00	1	0	0	0	1	0
5905006959547	1	780511	Rheostat	10.22	1	0	0	0	1	0
5820000823701	1	780717	**Fuse	.00	1	0	0	0	1	0
5365006347076	1	780614	Ring, Retaining	.80	1	0	0	0	1	0
5330008045964	1	780322	Valve, Irreversible	.00	1	0	0	0	1	0
5330007951313	1	780622	Seal, Plain, Encased	1.18	1	0	0	0	1	0
5910005430845	1	780605	Capacitor	2.97	1	0	0	0	1	0
5905007817101	1	780817	Switch	[illegible]	1	0	0	0	1	0
5330001794207	1	780523	Gasket	.27	1	0	0	0	1	0
5315009441093	1	780605	Pin Straight Head	3.73	1	0	0	0	1	0
5330005153432	1	780812	Retainer, Packing	.05	1	0	0	0	1	0
5310000664289	1	780914	Nut, Self Locking	.24	1	0	0	0	1	0
5305009823093	1	780510	Screw, Self Locking	.40	1	0	0	0	1	0
4820009033756	1	780502	Valve, Check	24.53	1	0	0	0	1	0
6145008190061	1	780525	Wire, Electrical	.02	1	0	0	0	1	0
6140010519844	1	780621	Battery	22.26	1	0	0	0	1	0
6140005787225	1	780625	Battery	.00	1	0	0	0	1	0
6615008270531	1	780606	Control Box SAS	.00	1	0	0	0	1	0
5945009233717	1	780502	Relay Assy	1741.00	1	0	0	0	1	0
4730007664613	1	780819	Elbow Tube	7.73	1	0	0	0	1	0
4730005413168	1	780522	Elbow Tube	1.84	1	0	0	0	1	0
4820001819227	1	780404	Cock, Drain	22.82	1	0	0	0	1	0
2840009427073	1	780317	Adapter Oil Strainer	12.16	1	0	0	0	1	0
1680009162562	1	780720	Seat Bottom, Troop	6.16	1	0	0	0	1	0
1680008548029	1	780814	Panel Fault	173.00	1	0	0	0	1	0
1680004919766	1	780917	Sensing Element Fire Det	163.00	1	0	0	0	1	0
1680004786018	1	780518	Panel Indicator	275.00	1	0	0	0	1	0
	4,404				245	38	24	205	4,135	2

*Source Army master data file catalog data agency, New Cumberland, PA
**No cost found for NSN

U.S. ARMY SAFETY CENTER

the people you turn to for safety

FT RUCKER 089218